Federal Motor Carrier Safety Administration
Office of Analysis, Research and Technology

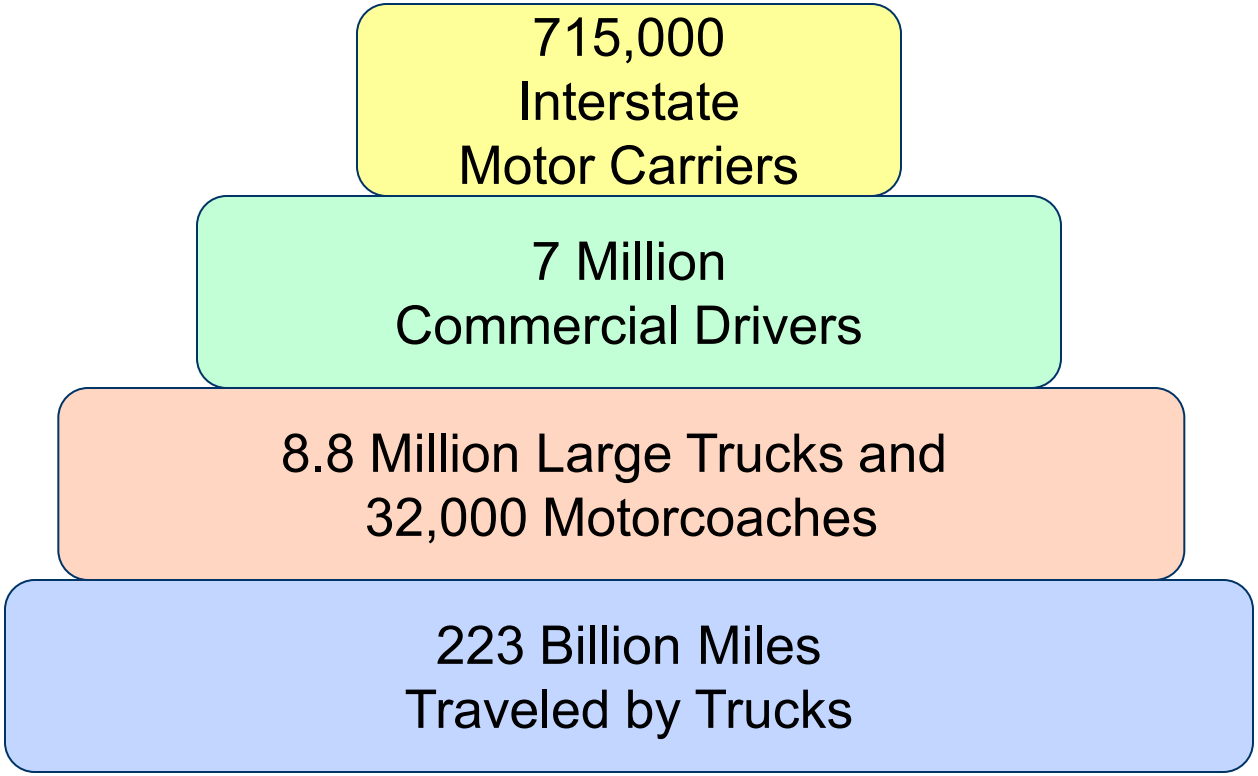
Integrated Vehicle-Based Safety Systems Program:

Heavy Truck Field Operational Test Preliminary Results

Jim Sayer, Ph.D.
University of Michigan
Transportation Research Institute

Chris Flanigan
Technology Division
Federal Motor Carrier Safety Administration

Scope of the Motor Carrier Industry



Source: 2008 FMCSA Statistics

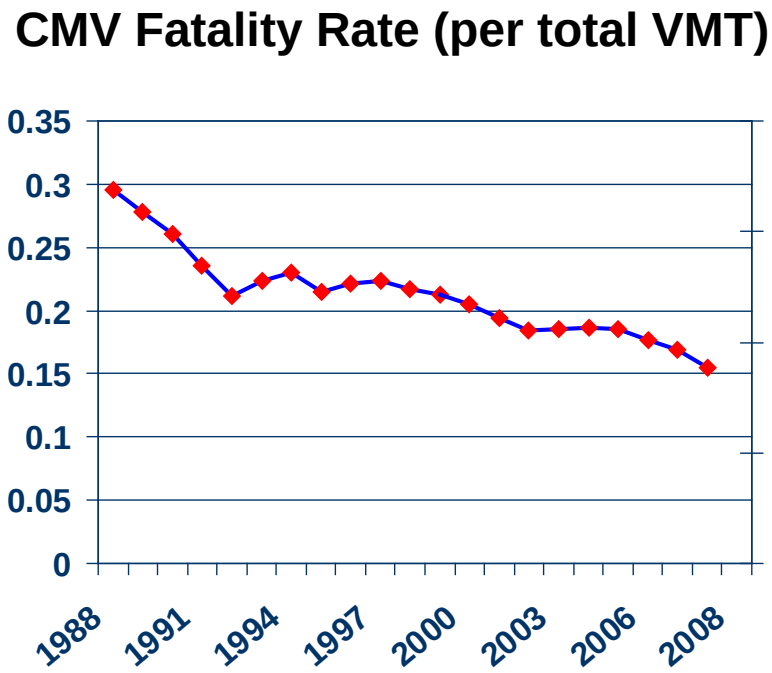
Commercial Motor Vehicle Safety Challenges

4,229
Fatalities

90,000
Injured Persons

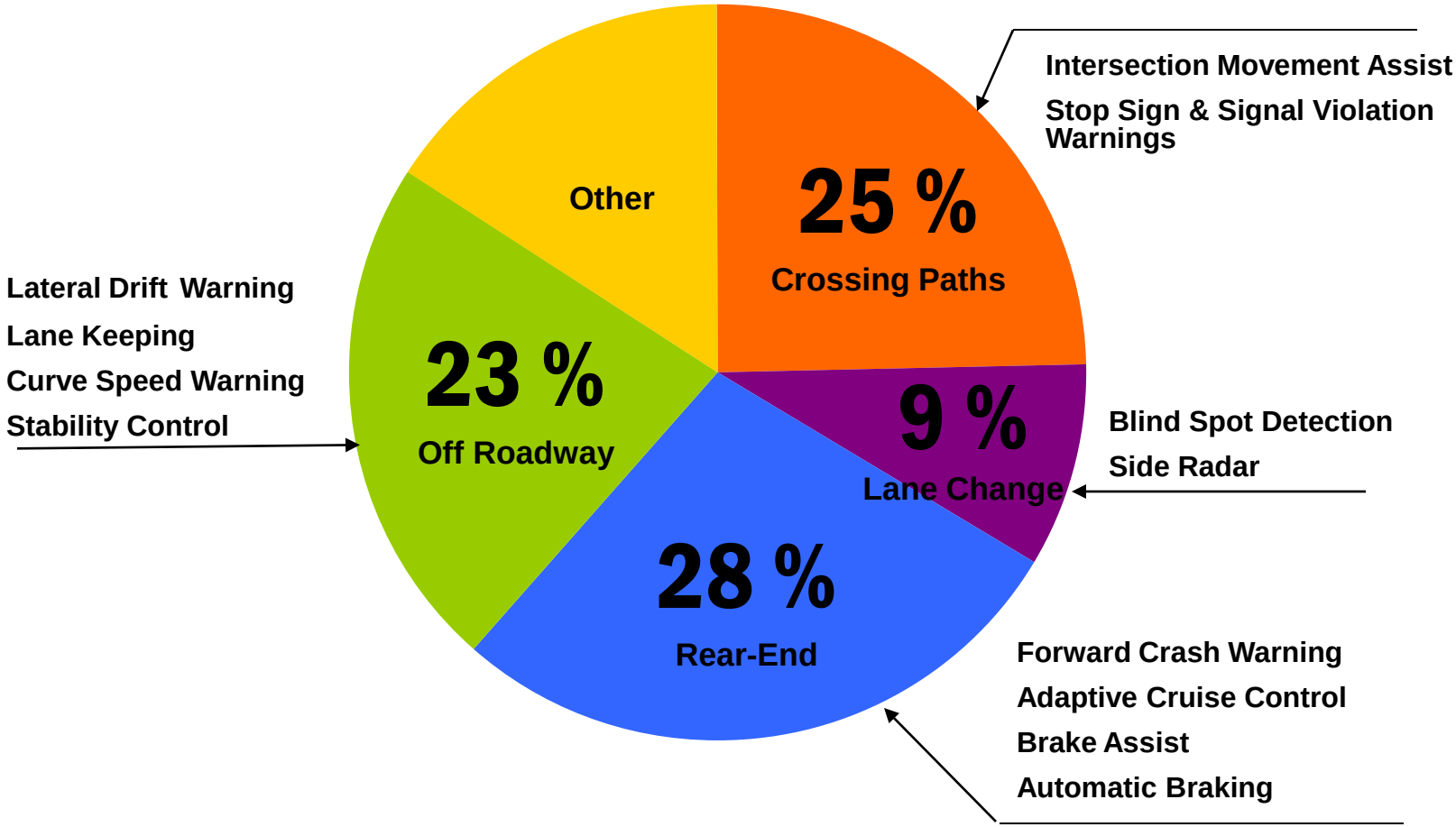
380,000
Police Reported Crashes

$60 Billion
Cost to Society



Sources: 2008 National Highway Traffic Safety Administration; 2008 Federal Highway Administration

Crashes of all Severities



Sources: 2008 National Highway Traffic Safety Administration

FMCSA Technology Division Onboard Safety Systems Deployment

- Cost-Benefit Study
- Stakeholder Survey
- Industry Demographics
- Effectiveness Evaluation
- IntelliDrive^{SM} Program
- **Integrated Vehicle-Based Safety Systems (IVBSS) Program**

What is the IVBSS Field Operational Test (FOT)?

- Cooperative agreement between the University of Michigan Transportation Research Institute (UMTRI) and the U.S. Department of Transportation (DOT)
  - Federal Motor Carrier Safety Administration (FMCSA)
  - National Highway Traffic Safety Administration (NHTSA)
  - Research and Innovative Technology Administration (RITA)
- Develop and field test integrated vehicle-based safety systems
  - Passenger cars and commercial trucks
- Almost 5-years in progress; $34.2M program
  - $25.6M from DOT, $8.6M in cost share

Federal Partners

U.S. Department of Transportation

Intelligent Transportation Systems

Joint Program Office

The IVBSS Team

Goals of IVBSS Program

- Integrate systems:
  - Lateral Drift Warning (LDW)
  - Lane Change/Merge (LCM)
  - Forward Crash Warning (FCW)
- Assess the systems for:
  - Safety benefits
  - Driver acceptance/ease of use
  - Willingness to purchase/marketability

Accident Problem

- Rear end, LCM and road departure crashes account for almost 50% of all motor vehicle fatalities in the U.S.
  - ≈ 60% of car crashes (19,100 fatalities/year)
  - ≈ 60% of truck crashes (1,100 fatalities/year)

The Vehicles

- Two fleets of vehicles
  - 16 cars (Honda Accord EX)
  - 10 trucks (International TranStar – Class 8)

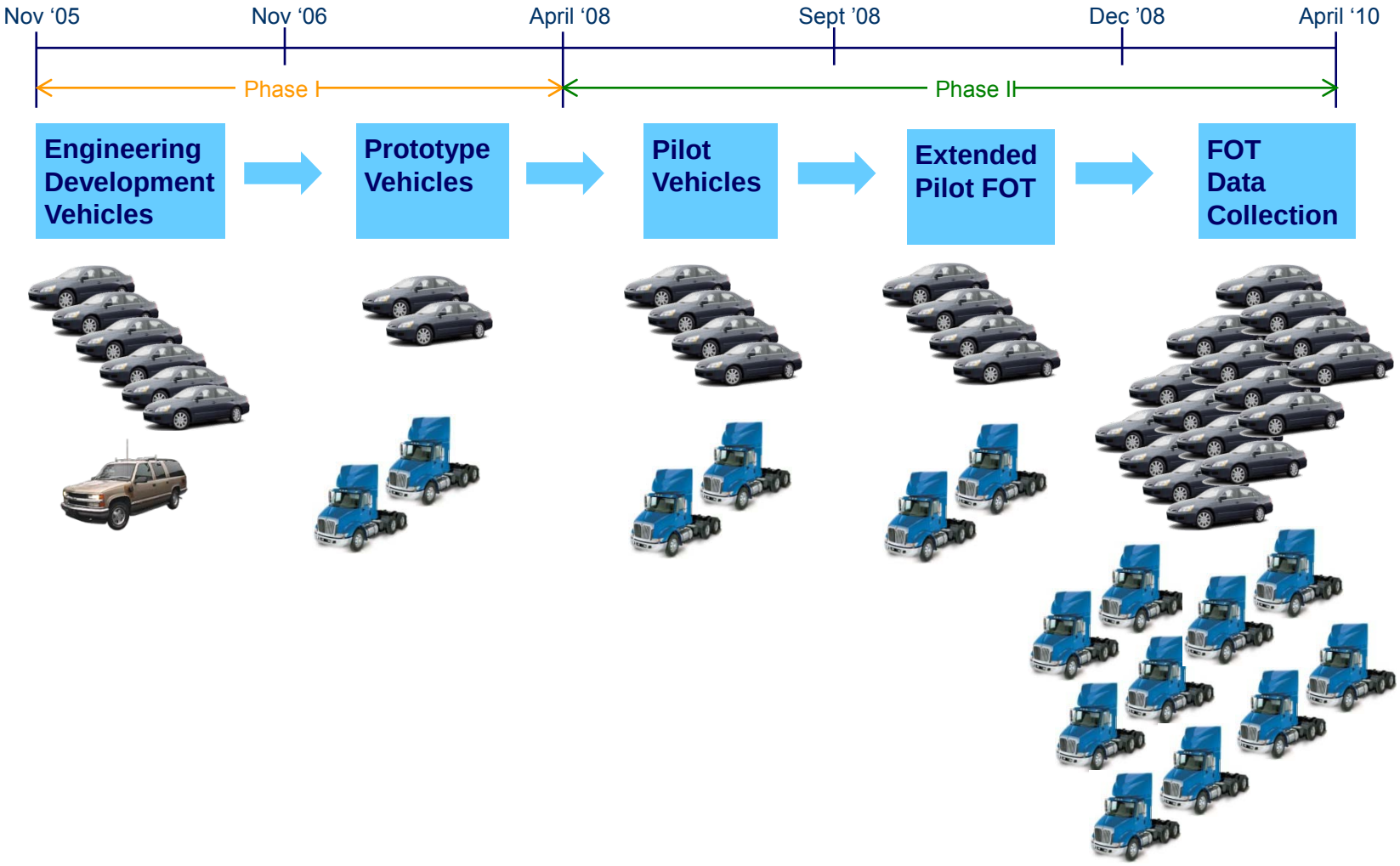
Key Research Questions

- Will the integrated system improve safety relative to individual warning systems?
- Do drivers understand and accept the integrated system?
  - Multiple threats and prioritization of warnings
  - Nuisance or false warnings
  - Effective driver-vehicle interface (DVI)
- How can integrated systems be tested objectively?

The Integration Challenge

- IVBSS evaluates integration from a variety of perspectives:
  - Enhanced performance of any one subsystem
  - Enhanced safety with multiple threats
  - Benefits of a fully integrated DVI
  - The role of the surrounding environment on a driver's decision to perform certain actions

Program Vehicles and Timing



Value of the IVBSS FOT

- Evaluate crash warning systems
  - Objective data:
    - System performance
    - System utilization
    - Accident reduction potential
  - Subjective data on willingness to buy and use
- Fundamental data on driver/traffic behavior
  - With and without the systems
  - Ability to address a multitude of questions

Integrated Warning System Operation

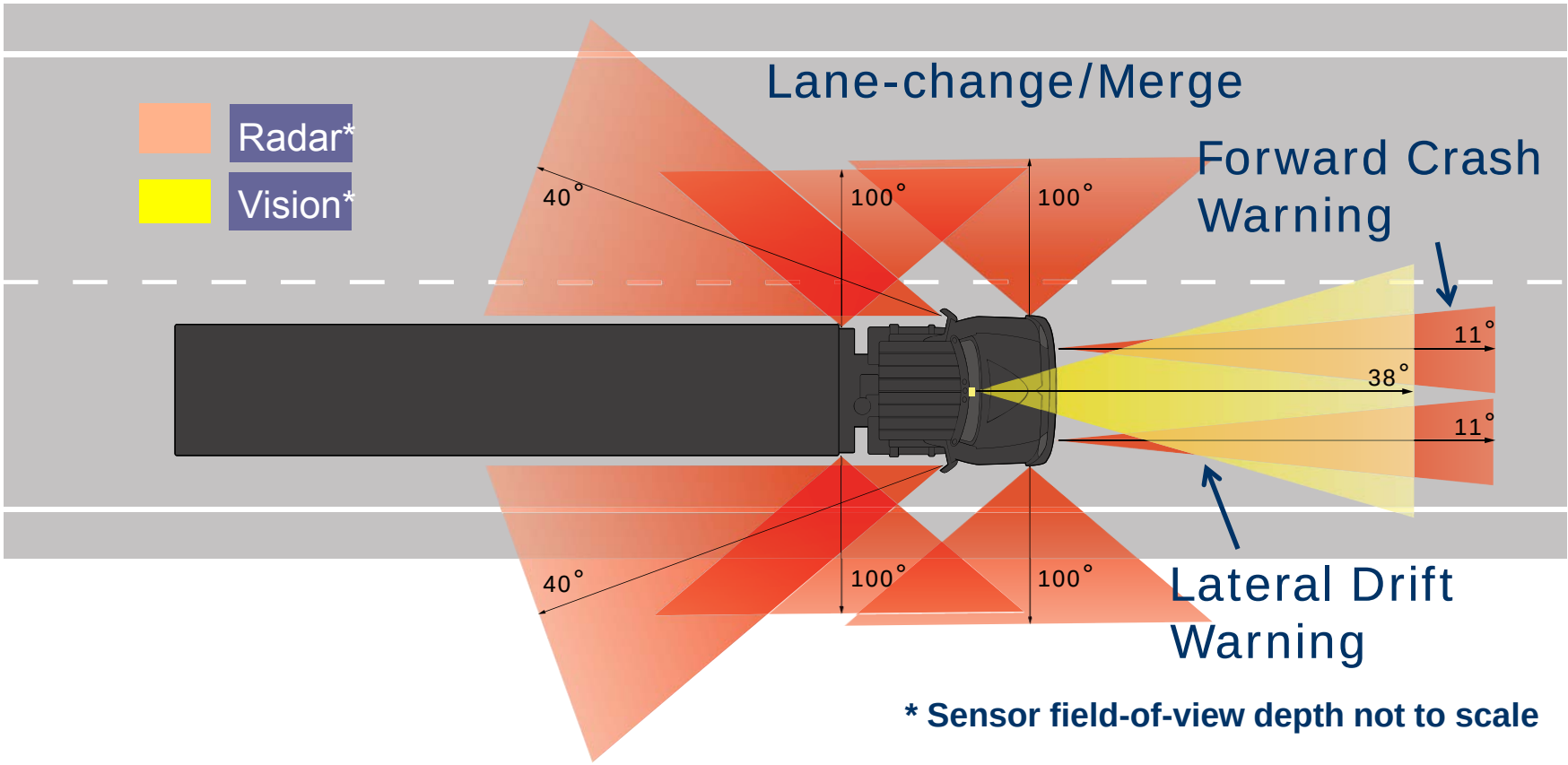
- LCM provides side object presence indicators to the driver and warnings of unsafe maneuvers
  - Provides directional side visual display and directional auditory display
- LDW tracks lane boundaries
  - Assesses threat of lateral departure and provides directional auditory warnings
- FCW provides headway warning and imminent collision detection
  - Provides collision warnings when a significant risk is detected, including stopped object detection

Arbitration and DVI Concepts of Operation

- Only warn for the most significant threat
  - Avoid contributing to driver errors, distraction, confusion, or information overload
  - Focus on supporting a timely and appropriate response from the driver

Heavy Truck Integration

Heavy Truck Sensor Coverage



*** Sensor field-of-view depth not to scale**

Heavy Truck FOT Location/Drivers

- FOT was run out of Con-way terminal in Romulus, Michigan
  - Includes pickup and delivery (P&D) routes in Metro Detroit, and line-haul routes in Michigan's lower peninsula, Ohio and northern Indiana
  - Two shifts per day
- 20 drivers enrolled
  - 18 male drivers completed
  - 8 P&D
    - Avg. age 48; 18 years CDL
  - 10 line-haul
    - Avg. age 50; 25 years CDL

Heavy Truck FOT Data

- Objective data
  - Multi-CPU data acquisition system, turn key and unobtrusive
  - Full-time dataset describing:
    - Vehicle performance
    - Driver performance
    - Vehicle location
    - Driving environment
- Subjective data
  - Questionnaires and debriefings

Heavy Truck FOT Data

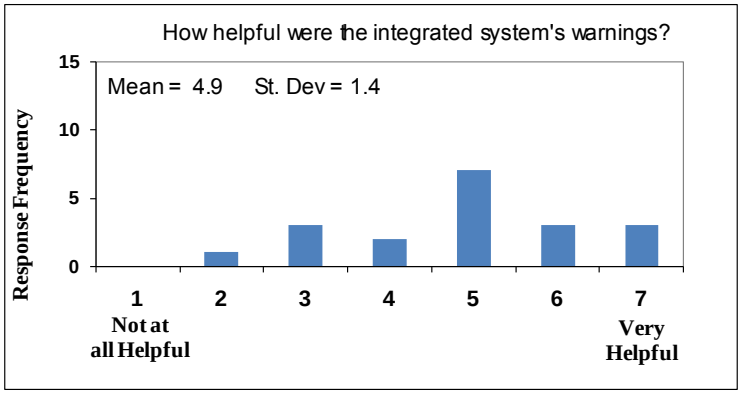
- Continuous data from IVBSS system, vehicle controller area network bus, and FOT sensors
  - 10 Hz to 50 Hz sampling rate
  - Hundreds of data signals
- Video from five cameras with adaptive frame rates and compression
- Audio

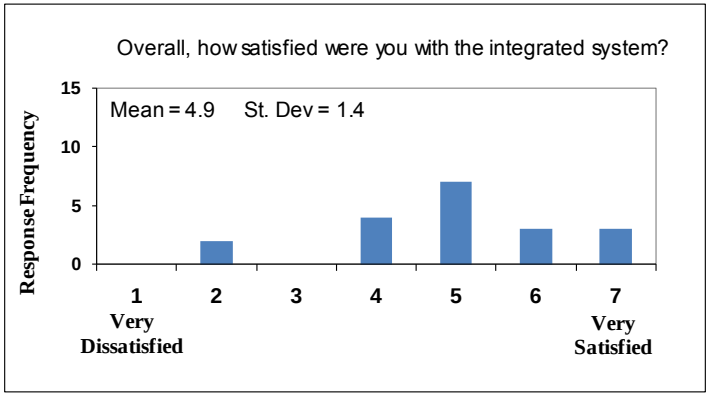
Heavy Truck Data Scope

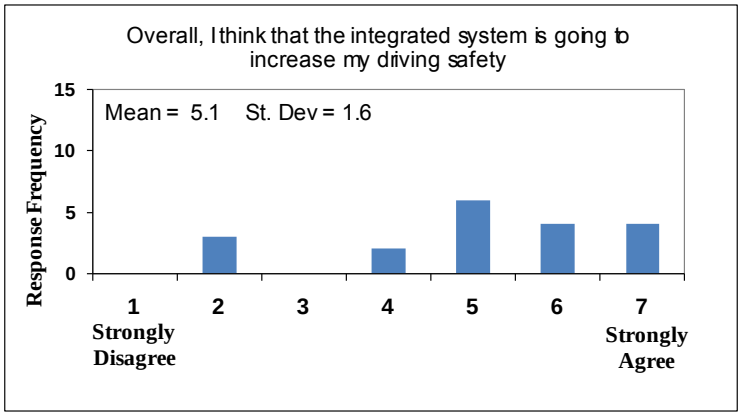
- February 2, 2009 thru December 14, 2009
  - 2 months without and approx. 8 months with the integrated system
- Total distance recorded: 647,103 miles
  - 44,756 trips
  - 16,738 hours
  - 1 crash
  - 85,250 warnings heard
- Warnings heard dominated by lateral events
  - 2.9 per 100 miles for FCW
  - 2.0 per 100 miles for LCM
  - 12.3 per 100 miles for LDW

Objective Data Visualization

Subjective Results

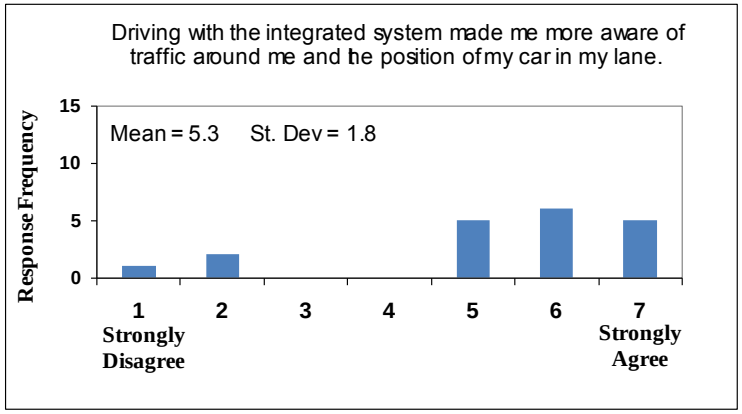


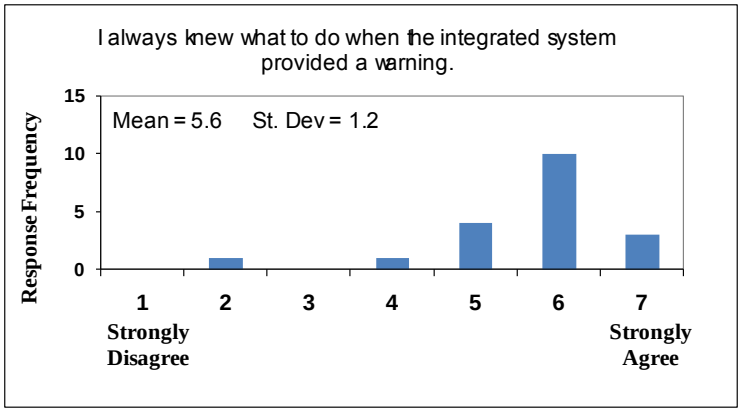


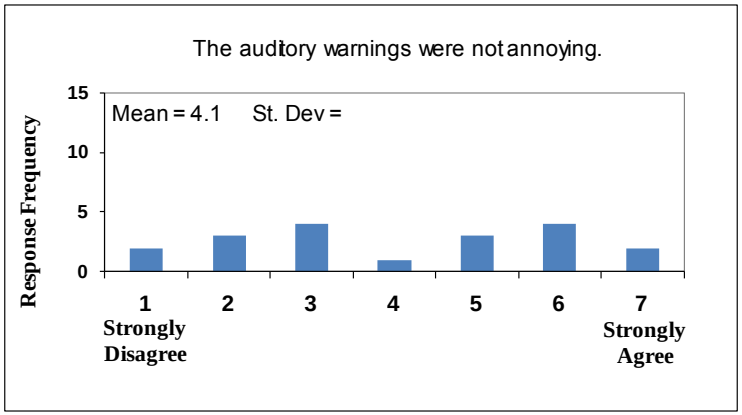


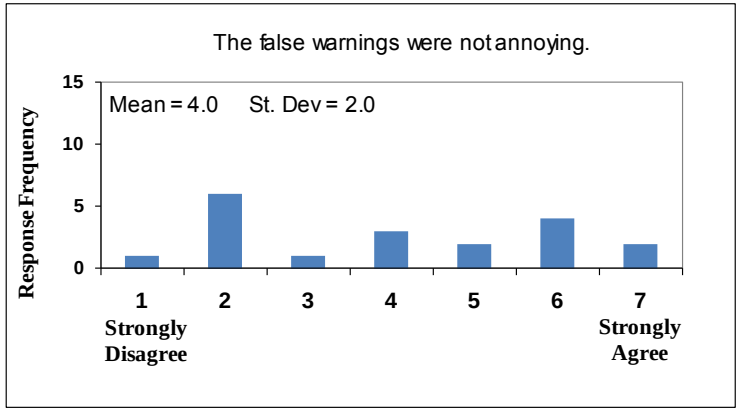
Question	Overall		Pickup and Delivery		Line-haul	
	Yes	No	Yes	No	Yes	No
Do you prefer to drive a truck equipped with the integrated system over a conventional truck?	15	3	6	2	9	1
Would you recommend that the company buy trucks equipped with the integrated system?	15	3	7	1	8	2

Subjective Results









Next Steps

- Continue Data Analyses
  - Draft of Key Findings report about to be submitted
  - Continue work on a Methodology and Results Report
- Public meeting on October 20
  - Eagle Crest Resort, Ypsilanti, MI
  - All-day review of the IVBSS program
  - Vehicles on-hand

Contact Information

Jim Sayer, Ph.D.
University of Michigan
Transportation Research Institute
jimsayer@umich.edu

Chris Flanigan
Technology Division
Federal Motor Carrier Safety Administration
chris.flanigan@dot.gov

http://www.umtri.umich.edu/ivbss.php

http://www.its.dot.gov/ivbss/index.htm